M017: ROPED MOVEMENT ON GLACIERS

TSP Number/Title	M017: Roped Movement on Glaciers
Effective Date	Implement next class iteration upon receipt
Supersedes TSP(s)/Lessons	None
TSP User	The following courses use this TSP: Mountain Instructor Qualification Course (MIQC) Basic Mountaineering Course (BMC) Assault Climber Course (ACC)
Proponent	United States Army Alaska, Northern Warfare Training Center
Improvement Comments	Send comments and recommendations on DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to: ATTN: TRAINING ADMINISTRATOR COMMANDANT USARAK NWTC 1060 GAFFNEY ROAD #9900 FORT WAINWRIGHT AK 99703-9900
Security Clearance/Access	Public domain
Foreign Disclosure Restrictions	The Lesson Developer in coordination with the USARAK NWTC foreign disclosure authority has reviewed this lesson. This lesson is releasable to foreign military students from all requesting foreign countries with Approval of Commandant USARAK NWTC.

PREFACE

Purpose

This training support package provides the instructor with a standardized lesson plan for presenting instruction for:

Task Number	Task Title
VIII.1200	Roped Movement on Glaciers

Technique of Delivery

Lesson Number	Instructional Strategy	Media
M017	Demonstration and Practical Exercise	None

This TSP contains

SECTION I **ADMINISTRATIVE DATA**

All courses including this lesson

Course Number	Course Title(s)
NA	Mountain Instructor Qualification Course
NA	Basic Mountaineering Course
NA	Assault Climber Course

Task(s) Taught or Supported

Task Number	Task Title
VIII.1200.A	Prepare for roped glacier movement
VIII.1200.B	Demonstrate roped movement on glaciers
VIII.1200.C	Demonstrate team arrest and self-rescue procedures for crevasse rescue
VIII.1200.D	Demonstrate crevasse rescue using brute force
VIII.1200.E	Demonstrate crevasse rescue using a Z-pulley system
VIII.1200.F	Demonstrate crevasse rescue using a U-pulley system
VIII.1200.G	Prepare a bivouac on a glacier

Task(s) Reinforced

Task Number	Task Title
VIII.1000	Individual movement on snow and ice.
VIII.1100	Roped climbing on snow and ice.
VIII.0801	Use a self-belay on a fixed rope.
VI.0200	Risk Management for Mountain Operations
VIII.0100	Mountain Travel and Walking Techniques
VIII.0300	Rope Management and Knots
VIII.0400	Anchors
VIII.0600	Belay Techniques

Test Lesson Number

Hours	Lesson Number	Lesson Title
	M020	BMC Mountaineering Review

Test Lesson Number

Hours	Lesson Number	Lesson Title

Prerequisite Lesson(s)

-M005, Risk Management for Mountain Operations
-M006, Mountain Travel and Walking Techniques, VIII.0100.02, VIII.0100.05, VIII.0100.07, VIII.0100.10.
-M008, Rope Management and Knots, VIII.0300
-M009, Anchors, VIII.0400.11, VIII.0400.12, VIII.0400.13, VIII.0400.14, VIII.0400.15, VIII.0400.16, VIII.0400.17.
-M011, Belay Techniques, VIII.0600.01-VIII.0600.10
-M021, Individual Movement on Snow and Ice, VIII.1000

References

Number	Title	Date	Additional Information
	NWTC Cold Weather Operations Manual	FY04	Updated yearly
	NWTC Mountain Operations Manual	FY04	Updated yearly
FM 3-97.6	Mountain Operations	November 2000	http://www.adtdl.army.mil/
FM 3-97.61	Military Mountaineering	August 2002	http://www.adtdl.army.mil/

Student Study Assignment	Read TSP M017.
Instructor Requirements	One Small Group Leader TAITC, and Summer IQC qualified.
Additional Support Personnel Requirements	None
Equipment Required	Instructor Equipment: • 1 x rope, dynamic kernmantle (dry-rope), 9mm x 60m • 1 x climbing harness with gear loops • 2 x webbing, nylon, 9/16” x 5.5’ • 2 x webbing, nylon, 1” x 10’ • 1 x webbing, nylon, 1” x 20’ • 4 x aluminum non-locking carabineers • 1 x aluminum locking “pear” shaped carabineer • 1 x large steel locking “D” shaped carabineer • 1 x pulley (optional) • 1 x mechanical ascender (optional) • 1 x cordalette, dynamic kernmantle, 7mm x 6’ • 1 x cordalette, dynamic kernmantle, 7mm x 12’ • 2 x ice screws or snargs • 1 x snow picket • 1 x 70cm-90cm ice axe with wrist leash Student Equipment: • 1 x climbing harness, with or without gear loops • 2 x webbing, nylon, 1” x 10’ • 1 x webbing, nylon, 1” x 20’ • 4 x aluminum non-locking carabineers • 1 x aluminum locking “pear” shaped carabineer • 1 x large steel locking “D” shaped carabineer • 1 x cordalette, dynamic kernmantle, 7mm x 6’ • 1 x cordalette, dynamic kernmantle, 7mm 12’ • 1 x ice screw or snarg • 1 x snow picket • 1 x 70cm-90cm ice axe with wrist leash • Pen and notepad
Materials Required	Instructor Materials: • TSP • NWTC Mountain Operations Manual • USARAK NWTC Risk Management Guide Student Materials: • NWTC Mountain Operations Manual • USARAK NWTC Risk Management Guide

Classroom, Training Area and Range Requirements	The glacial training/ testing area must be large enough to facilitate students traveling in rope teams with instructor.
Ammunition Requirements	None
Instructional Guidance	Before presenting this lesson, instructors must thoroughly prepare by studying this lesson and identified reference material.

SECTION II **INTRODUCTION**

Method of instruction: Class
Type of instruction: Small Group
Instructor to student ratio: 1:8
Time of instruction: 6 Hours
Media used: None

Motivator

Glacier travel is a very specialized mountaineering skill, for one principal reason: the mountaineer must contend with crevasses, the chasms that split a glacier as its great mass of frozen snow slowly flows downhill. To travel safely on a glacier, you need the ability to detect and avoid crevasses and other glacier hazards and to get out of a crevasse if you or the members of your rope team fall in. Since the hazards of glacier travel are many, a unit's effectiveness in overcoming these hazards depends upon the training received. This lesson contains the basic information required to allow personnel to overcome these obstacles and to move over glaciated terrain.

Terminal Learning Objective

ACTION	Demonstrate proper roped movement on glaciers
CONDITION	On glaciated terrain, with a 60m 9mm rope per 3-4 individuals, adequate climbing equipment and sling material
STANDARD	Demonstrate proper roped movement on glaciers IAW the NWTC Mountain Operations Manual.

Safety Requirements

Ensure that students:

- Receive a risk assessment prior to movement to the training area and before practical exercises.
- Have all necessary equipment for the PE's, to include any additional equipment required by the NWTC SOP.
- Have two full canteens and drink adequate water to avoid becoming dehydrated.
- Receive a briefing on the symptoms of heat injury or cold weather injury, as appropriate.

Risk Assessment Level

Determined by instructor

Environmental Considerations

None

Evaluation

You will be evaluated on this task during the Alpine FTX and questions related to this subject may appear on the written test.

Instructional Lead-in

You have already mastered all of the skills of rope management and knots, rope installations, and over-snow movement that are required to begin your instruction on roped glacier travel. You will now use a broader combination of these skills to negotiate obstacles over glaciated terrain.

The principle dangers and obstacles to movement in glacial areas are crevasses, icefalls, and ice avalanches. Snow-covered crevasses make movement on a glacier very treacherous. In winter, when visibility is poor, the difficulty of recognizing them is increased. Toward the end of the summer, crevasses are widest and covered by the least snow. Snow bridges constitute the greatest potential danger in movement over glaciers in the summer. On the steep pitch of a glacier, ice flowing over irregularities and cliffs in the underlying valley floor causes the ice to break up into ice blocks and

towers and seracs. This jumbled cliff of ice is known as an icefall. Icefalls present a major obstacle to safe movement of troops on glaciers.

SECTION III **PRESENTATION**

ELO A

ACTION	Prepare for roped glacier movement
CONDITION	On glaciated terrain, with a 60m 9mm rope per 3-4 individuals, adequate climbing equipment and sling material
STANDARD	Prepare for roped glacier movement IAW the NWTC Mountain Operations Manual.

Learning Step/Activity 1 – Prepare for Glacier Travel

a. Moving on glaciers brings about the hazard of falling into a crevasse. The first rule of safe glacier travel is very simple: rope up. In winter this rule always holds true. In summer months, this rule holds true when traveling above the firn line where the glacier gets more snow every year than it loses to melting, making it likely that snow covers some crevasses. The risk of traveling in the accumulation zone can be managed to an acceptable level when ropes are used for connecting the team members. In summer, if travel will remain below the firn line, individuals will need only ice axe and crampons for safe travel.

b. Tying into the rope:

1. Three to four people will tie in to one rope at equal distances from each other. If three people are on a team, one person ties into the middle and the other two at the ends. If four people are on a team, divide the rope into thirds. Two will tie into the end and the other two will tie into the rope keeping equal lengths of rope between all four individuals.
2. Each individual should wear a pre-sewn seat harness or the improvised seat harness.
3. An improvised chest harness should also be worn; if the climber falls the chest harness will keep the climber upright.
4. Each climber ties a figure eight loop and clips this loop to the harness with a locking pear shaped carabiner.
5. The rope is then clipped to the chest harness.
6. Take a 6 foot length of cordallete and tie it into a continuous loop with the double fisherman's knot. Attach this to the rope exiting from the chest harness with a prusik with three wraps. Clip the cordallete to the seat harness with another locking carabiner.
7. Take a 12 foot length of cordallete and tie it into a continuous loop with the double fisherman's knot. Attach this to the rope between the first prusik knot and the chest harness with a prusik with three wraps. Tuck the end of the cordallete into a pocket. This cordallete does not have to be tied to the rope and may be carried on a carabiner attached to the seat harness.
8. Skis or snowshoes should now be donned, if applicable.
9. The rucksack should be rigged for glacier travel. Take a length of webbing and girth hitch it to the frame. Place an oval carabiner into the webbing. Don the pack and clip the carabiner to the rope between the climbing harness and the chest harness.
10. If traveling with a sled, secure it to the rucksack for towing and connect the rear of the sled to the rope with cordallete using the prusik knot. This will prevent it from hitting the climber should he fall into a crevasse.
11. All items should be secured to either you or the rope/harness to prevent inadvertent release and loss of necessary items or equipment.

c. Two-person rope teams should be avoided. The difficulties of crevasse rescue are compounded when one member of a two person rope team falls and the other must perform all of the rescue duties, to include holding the fall. This technique is best left to experts in the field of mountaineering and will not be discussed further here. For different reasons, five or more individuals should not rope together. The length of rope between individuals will not be long enough to span the width of most crevasses.

PREPARATION FOR ROPED MOVEMENT

ELO B

ACTION	Demonstrate roped movement on glaciers
CONDITION	On glaciated terrain, with a 60m 9mm rope per 3-4 individuals, adequate climbing equipment and sling material
STANDARD	Demonstrate roped movement on glaciers IAW the NWTC Mountain Operations Manual.

Learning Step/Activity 1 – Roped Movement

Note: A large, safe open area is essential to gain an understanding of the basics and challenges of roped movement.

a. Now that the rope is attached to all rope team members, proper rope management is essential:

1. All rope team members start in a safe area. As the first rope team member moves out of this safe area, he will need to be belayed out. The purpose of this belay is to prevent the lead member from taking a long fall into a crevasse because there will be a good deal of slack between each rope team member until the team has moved the length of the rope. One method is for the second member of the team to take up the slack between himself and the climber by sliding the prusik up the rope until all of the slack is removed. The second team member can then belay the leader out by allowing the rope to slide through the prusik. If the lead climber takes a fall the prusik will lock off and the second climber can arrest the fall be executing self arrest. When all of the slack is removed between the first two climbers the second climber begins moving. The third climber belays the second climber out in the same manner.

b. The rope should remain extended between all climbers, not taut, but without undue slack. A rope that is fully extended between climbers is insurance against a long plunge into a hidden crevasse. With a slack rope, a climber's initial breakthrough into a crevasse can't be immediately resisted by the climber who follows. The falling climber therefore drops farther, increasing chances of hitting something or becoming wedged if the crevasse narrows. For the climbers holding the fall, a slack rope can mean a much greater tug on the rope from the falling climber, creating the danger of being dragged into the hole themselves.

A good rule of thumb is that the rope should run from the harness to the ground in about a 45 degree angle.

c. To help keep slack out of the rope, a rope leader needs to set a pace the others can follow for a long time. For their part, the second and third climbers must try to closely match the pace of the leader so the rope stays extended. At sharp turns, there is a tendency for the rope to go slack as the climber in front of you heads in a new direction and then to tighten as you near the turn yourself. Throughout the turn,

adjust your pace to keep out the slack.

d. Skis and snowshoes provide excellent flotation and may assist travelers in moving across snow bridges. Skiers must be proficient. Down hill skiing while roped up, even on moderate slopes makes rope management very difficult. Snowshoes may be the better choice for soldiers not accustomed to skiing while roped up.

e. If a team member falls into a crevasse, the remaining members go into team arrest, assess the situation, and use the necessary technique to remove the person from the crevasse. Rescue techniques will be discussed in later lessons. For now, route selection can go along way to preventing a crevasses fall in the first place.

ROPE TEAMS MOVING IN
THE ACCUMULATION ZONE OF A GLACIER

Learning Step Activity 2 – Moving on a glacier: Route planning, selection and hazard evaluation

a. Route planning considerations include:

1. Conduct a map, photo or aerial reconnaissance. You can get a head start on the planning by studying photos of the glacier; crevasse patterns generally remain fairly constant from year to year. Look for heavily crevassed areas evidenced by depression in the snow. Look for icefalls and avenues with high potential for ice or snow avalanche danger. Consider stream crossings, and the difficulty of getting onto and off of the glacier. Enemy observation must also be considered. A safe route relative to the mountain hazards may be a dangerous one due to enemy direct or indirect coverage of the area. The route may need to be undertaken at night, so a proper reconnaissance is essential.

2. Open crevasses are obvious, and their presence is an inconvenience rather than a danger to movement. Narrow cracks can be jumped, provided the take off and landing spots are firm and offer good footing. Wider cracks will have to be circumvented unless a solid piece of ice joins into an ice bridge strong enough to support at least the weight of one member of the team. Such ice bridges are often formed in the lower portion of a crevasse, connecting both sides of it.

3. Usually the upper part of a glacier is permanently snow covered. The snow surface here will vary in consistency from dry powder to consolidated snow. Below this surface cover are found other snow layers that become more crystalline in texture with depth, and gradually turn into glacier ice. It is in this snow-covered upper part of a glacier that crevasses are most difficult to detect, for even wide crevasses may be completely concealed by snow bridges.

b. Route selection and hazard evaluation:

1. While on a glacier, there are several tips for detecting crevasses: Keep an eye out for sagging trenches in the snow that mark where gravity has pulled down on snow over a crevasse. A sagging trench on the surface of the snow is a prime characteristic of a hidden crevasse. Be wary after storms. New snow can fill a sagging trench and make it blend into the surrounding surface. Be especially alert in areas where you know crevasses form, such as where a glacier makes an outside turn or where slope angle increases. Sweep your eyes to the sides of the route regularly, checking for open cracks to the left or right. Cracks could hint at the presence of crevasses extending beneath your path.

2. Snow probing is a technique to use if you have found a suspicious looking area and want to search it for crevasses. If your probe locates a crevasse, continue probing to find its true lip. Probe with

your ice ax, thrusting the shaft into the snow a couple of feet ahead of the snow you are standing on. Keep the ax perpendicular to the slope and thrust it in with a smooth motion. If resistance to the thrust is uniform, you have established that the snow is consistent to at least the depth of your ax. If resistance lessens abruptly, you've probably found a hole. If your route must continue in the direction of this hole, use further ax thrusts to establish its extent.

3. Snow bridges over crevasses are formed by windblown snow that builds a cornice over the empty interior of the crevasse. As the cornice grows from the windward side, a counter drift is formed on the leeward side. The growth of the leeward portion will be slower than that to the windward so that the juncture of the cornices occurs over the middle of the crevasse only when the contributing winds blow equally from each side. Bridges can be formed also without wind, especially during heavy falls of dry snow, and since cohesion of dry snow depends only on an interlocking of the branches of delicate crystals, such bridges are particularly dangerous during the winter. When warmer weather prevails the snow becomes settled and more compacted, and may form firmer bridges. Other, sturdier bridges are really thin isthmuses between two crevasses, with foundations that extend deep into the body of the glacier. This knowledge is sobering, especially when you think about the width of some crevasses, but there are a number of ways to get safely across a field of crevasses:

a. In the arctic and sub-artic regions, winter snow bridges may be weaker especially early in the season or if conditions have been particularly dry and cold; route selection should obviously favor areas that are not heavily crevassed.

b. In warmer, wetter temperate regions or during the summer months, it may be possible to move through crevasse fields by moving on a route perpendicular to the crevasses. Snow bridges will strengthen as freeze thaw cycles become more prevalent. During the warmer periods of the day, snow bridges will be weaker; travel in the colder periods of a day is advised. The strength of a snow bridge varies tremendously with temperature. An arch that might support a truck in the cold of winter or early morning may collapse under its own weight during an afternoon thaw. Cross every bridge with caution every time. Don't assume that because it held in the morning, that it is safe in the afternoon. The end of the summer months often find snow bridges at their weakest. Travel in the accumulation zones will be very difficult during these times. It may be necessary to find the end of crevasses and make an end run around them. A quarter mile walk may gain you only 20 or 30 feet of forward progress, but it often beats a direct confrontation with the crevasse.

c. Once a crevasse has been completely bridged, its detection is difficult. Bridges are generally slightly concave because of the settling of the snow. This concavity is perceptible in sunshine, but difficult to detect in flat light. If the presence of hidden crevasses is suspected, the leader of a roped team must probe the snow in front of him with the shaft of his ice ax. As long as a firm foundation is encountered, the team may proceed, but should the shaft meet no opposition from an underlying layer of snow, a crevasse is probably present. In such a situation, the individual probing should probe closer to his position to make sure that he is not standing on the bridge itself. If he is, he should retreat gently from the bridge and determine the width and direction of the crevasse. He should then follow and probe the margin until a more resistant portion of the bridge is reached.

d. In crossing crevasses, distribute the weight over as wide an area as possible. Many fragile bridges can be crossed by lying down and crawling to the other side. Skis or snowshoes will also help with weight distribution. When moving parallel to a crevasse, all members of the team should keep well back from the edge and follow parallel but offset courses.

e. Jumping is one of the least common tactics for crossing a crevasse. Most jumps across crevasses are short, simple leaps. If you're planning a desperate lunge, be sure you've ruled out all the alternatives and see that you are well belayed. While being well supported by a taut rope or belayed, probe to find the true edge of the crevasse. If you need a running start for the jump, tramp down the snow for better footing. As a final precaution, put on parka, mittens, hat, check prusiks and harness, and spool out the amount of rope slack needed from the belayer. Then jump- with your ice ax in the self arrest position, ready to help you claw over the edge if you're shy of a clean landing. With the rope now linked to the landing side, the other climbers have a less dangerous jump ahead. The belay rope can help pull up on any jumper who falls just short of the target.

f. Climbing into a crevasse, crossing it at the bottom, and climbing out the other side may be necessary. This tactic should be attempted only by a strong, highly trained, and well-equipped party that is ready to provide a good belay, plus assistance in case the crevasse bottom collapses and leaves the climber hanging.

g. Certain crevasse patterns preclude the rule of keeping the rope at right angles to the crevasses. If the route demands travel that is parallel to crevasses, the echelon formation can help. The echelon formation includes traveling in a parallel direction on either side of the crevasses you are traveling by. The rope team will be strung out diagonally, the team leader up front, with the other rope team members staggered on either side of the crevasses. This formation is safest on stable, heavily

crevassed glaciers where location of the crevasses is known and the risk of hidden holes is small. The formation offers an alternative to following in the leaders' footsteps through a maze of crevasses where single-file travel is impractical. Avoid moving in echelon where hidden crevasses are likely.

ELO C

ACTION	Demonstrate team arrest and self-rescue procedures for crevasse rescue
CONDITION	On glaciated terrain, with a 60m 9mm rope per 3-4 individuals, adequate climbing equipment and sling material
STANDARD	Demonstrate team arrest and self-rescue procedures for crevasse rescue IAW the NWTC Mountain Operations Manual.

Learning Step/Activity 1 – Team Arrest

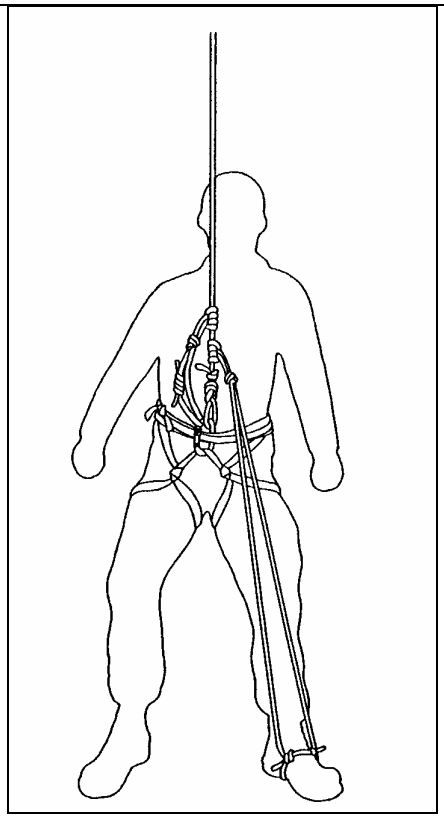
a. If all rope team members are adhering to the principles of roped movement, crevasse falls will be rare. However, climbers do on occasion punch through snow bridges. Most of the time these 'falls' are not very dramatic. Most crevasse falls will be no more than body height into the opening if the rope is kept snug between each person. A fall usually means one person on the team has slipped through a hole in a bridge, and these falls rarely put the climber deeper than waist deep; this is usually due to good rope management by the team and the bulk of a pack suspending the individual in the hole. When an unexpected break-through by the leader takes place, the second and third immediately go into the self-arrest position to arrest the fall and/or prevent the climber from slipping further into the hole. This is known as team arrest.

Learning Step/Activity 2 – Self-Rescue

a. The simplest and most common method for getting someone out of a crevasse is having the person climb out of the crevasse while being belayed. If the leader has fallen only partially through the snow bridge, he is supported by the snow forming the bridge and should not thrash about as this will only enlarge the hole and result in deeper slide into the hole. All movements should be slow and aimed at rolling out of the hole and distributing the weight over the remainder of the bridge. The rope should remain tight at all times and the team arrest positions adjusted to do so. It is generally safer to retain the rucksack, as its bulk often prevents a climber from slipping deeper into the hole. Should a team member other than the leader experience a partial fall, the rescue procedure will be the same as the one for the leader, complicated by the position on the rope.

b. When the person falls into a crevasse, the length of the fall depends upon how quickly the fall is arrested and where in the bridge the break takes place. If the fall occurs close to the near edge of the crevasse, it usually can be checked before the climber has fallen more than six feet. However, if the person was nearly across, the fall will cause the rope to cut through the bridge, and then even an instantaneous check by the other members will not prevent a deeper fall. In this situation the climber can still perform a self-rescue while the other climbers remain in team arrest. To perform self-rescue:

1. Remove the rucksack. Remove the rope from the chest harness connection.
2. Take the long cordallete out of the pocket it was stowed in and pull the double fisherman's loop apart to form a foot stirrup. Place the foot stirrup around one or both feet. (If this cordallete was stowed on the seat harness, attach it to the rope with a prusik below the short prusik cordallete, create the foot stirrup and attach it to the feet).
3. The picture below is the proper configuration for self rescue. The rucksack is omitted for clarity; it should be hanging below the legs.
4. The climber can now ascend the rope by alternating movement of the upper and lower prusik knots up the rope. First stand in the foot stirrup; the prusik will support your weight. Move the upper, short prusik up the rope as high as you can. Rest your weight on this prusik. Move the lower prusik up; bending the leg(s) as you do so. Stand again in the stirrup and repeat the process unitl you reach the lip of the crevasse. To stand up you will need to pull on the rope as you stand up.
5. Pulling over the lip and onto solid ground is often the most difficult part of this exercise. This is especially true if the lip is overhanging. You can use the ice axe to help climb out or attach another sling to the rope to assist in climbing out of the hole.



PRUSIK ASCENDING TECHNIQUE

The priority of the climber is to get out of the crevasse. If the rucksack or sled is hindering this in any way, the climber should jettison this equipment; it can be recovered later.

This exercise should be practiced either in an open crevasse, while belayed from above or in an area where a fixed rope can be suspended from a tree, an overhanging wall or building with solid support structures near the ceiling. Getting the length of the two pieces of cordallete is often the most important part of having an efficient self-rescue system.

ELO D

ACTION	Demonstrate crevasse rescue using brute force
CONDITION	On glaciated terrain, with a 60m 9mm rope per 3-4 individuals, adequate climbing equipment and sling material
STANDARD	Demonstrate crevasse rescue using brute force IAW the NWTC Mountain Operations Manual.

Learning Step/Activity 1 – Brute Force Method

a. The brute force method can be used to pull a team member out of a hole. This method involves the members of the rope team walking, crawling etc. away from the hole, and pulling the fallen team member out. Other rope teams can come forward to assist in doing this. This method should be used only when you are able to communicate with the fallen team member. Climbers have been killed by rope teams attempting to rescue them when they became stuck under an overhang and the rope team continued to pull.

ELO E

ACTION	Demonstrate crevasse rescue using a Z-pulley system
CONDITION	On glaciated terrain, with a 60m 9mm rope per 3-4 individuals, adequate climbing equipment and sling material
STANDARD	Demonstrate crevasse rescue using a Z-pulley system IAW the NWTC Mountain Operations Manual.

Learning Step/Activity 1 – Setting the initial anchor: Crevasse Rescue with Z-Pulley

a. There may be situations where the arresting team cannot communicate with the fallen climber. The climber may be injured or unconscious or otherwise unable to help himself. Other rope teams may not be available to assist. In these situations, the arresting climbers must perform the rescue. The first step to this rescue is to get the fallen climber onto an anchor system so that the other team members can set up a raising system. To build the anchor (for this scenario, assume that there is a three member rope team, the fallen climber is #1, middle #2 and last # 3):

1. Rope team member #2 attempts to communicate with #1. #1 indicates that his leg is broken and he needs assistance.
2. The entire load of the fallen climber must be placed on #2 to allow #3 to move forward and anchor the rope. #3 slowly releases his portion of the load onto #2, always being prepared to go back into self-arrest should #2's position begin to fail.
3. Once #2 is confident that he can hold the load, #3 will proceed to #2's position, using the prusik as a self belay. In this way the rope remains reasonably tight between #2 and #3.
4. When #3 reaches #2's position he will establish a bombproof anchor. This should be either a dead man anchor or a two point equalized anchor, as a minimum. For simplicity, the anchor should be set up between the hole and the #2 man. Snow conditions, the size of the crevasse, or other considerations may dictate a different anchor location.
5. #3 ties a prusik with the 12 foot cordallete onto the rope leading to #1 (between the hole and the #2 man). #3 Attaches the cordallete to the anchor with a locking carabiner or two oval carabiners, gates opposite and opposed. If the cordallete does not reach the anchor, girth hitch slings to the cordallete until the anchor can be reached. The prusik knot is adjusted toward the load.
6. #2 can then transfer the load of #1 onto the anchor. Do this gradually, preparing to arrest again if the anchor fails.
7. Once satisfied with the anchor, #3 should clip a safety line to the anchor and can untie from the end of the rope.
8. #2 can now check on the fallen climber and prepare the lip of the crevasse for raising the climber. To do this the #2 climber clips a safety line to the anchor. #2 removes the short prusik and re-attaches it below the prusik holding the load of the climber. #2 now unclips from the climbing rope. #2 unclips the safety line and uses the prusik as a belay down to the hole. #2 should pad the lip to prevent the rope from cutting into the snow. A rucksack or ice axe can be used to accomplish this. #2 communicates with #1 and the two develop a plan to get #1 out of the hole.

Learning Step/Activity 2 – Rigging the Z-Pulley

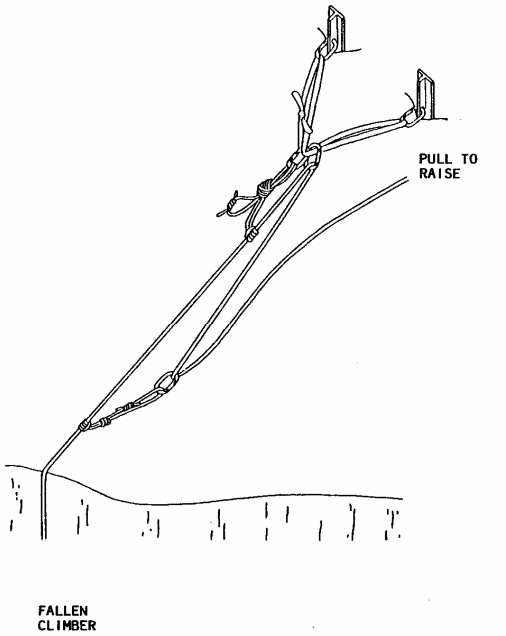
a. A simple raising system can be rigged to haul the victim out of the crevasse. The "Z" pulley hauling system is one of the simplest methods and the one most commonly used in crevasse rescue. The basic "Z" rig is a "3 to 1" system, providing "mechanical advantage" to reduce the workload on the individuals operating the haul line. In theory, it would only take about 33lbs of pull on the haul rope to raise a 100lb load with this system. In actual field use, some of this mechanical advantage is lost to friction as the rope bends sharply around carabineers and over the crevasse lip. The use of mechanical pulleys can help reduce this friction in the system and could be used if available. The following describes rigging of the system:

1. The slack rope exiting the anchor prusik is clipped into a separate carabineer attached to the anchor. A pulley can be used here if available.
2. #2 will use #3's short prusik to rig the haul prusik. He moves toward the crevasse lip (still on his own self-belay) and ties #2's short prusik onto #1's rope (load rope) as close to the edge as possible.
3. Another carabineer (and pulley if available) is clipped into the loop of the "haul prusik" and the rope is clipped to the slack rope (or attached through the pulley).
4. #2 then moves toward the anchor and #3. #3
5. #3 must manage the anchor prusik, allowing the load rope to pass through it without binding. If the "haul prusik" reaches the anchor before the victim reaches the top, the load is simply placed back

on the “anchor prusik” and #3 moves the “haul prusik” back toward the edge. The system is now ready for another haul.

6. This process is continued until the climber is raised to the surface.

NOTE: With the “3 to 1” system, the load (fallen climber) will be raised “1 foot” for every 3 feet of rope taken up during the haul.



Z PULLEY HAULING SYSTEM
(PADDING OF EDGE AND CLIMBERS OMITTED FOR CLARITY)

ELO F

ACTION	Demonstrate crevasse rescue using a U-pulley system
CONDITION	On glaciated terrain, with a 60m 9mm rope per 3-4 individuals, adequate climbing equipment and sling material
STANDARD	Demonstrate crevasse rescue using a U-pulley system IAW the NWTC Mountain Operations Manual.

Learning Step/Activity 1 – U-Pulley

a. The U-Pulley as described here requires a second rope team. This is a fast, efficient method of extracting someone from a crevasse. Assume a climber has fallen into a crevasse and the remainder of the team is in self-arrest.

1. The second rope team approaches the edge of the hole.
2. The team leader of this rope team communicates with the fallen climber.
3. The team leader uses the prusik to take rope between him and his second.
4. The slack is lowered to the fallen climber.
5. The fallen climber takes the slack and clips it to a locking carabiner attached to his harness.
6. The team leader on the surface can pad the lip. The team leader then moves away from the crevasse edge and goes into self-arrest.
7. The team leader is now the anchor point. (Alternatively, the team leader can build a bombproof anchor and attach the rope to it with a cordallete and prusik knot).
8. The other members of his team walk backward to raise the fallen climber out of the hole.
9. The team members of the fallen climber manage the rope to ensure they continue to support some of the load.

ELO G

ACTION	Prepare a bivouac on a glacier
CONDITION	On glaciated terrain, with a 60m 9mm rope per 3-4 individuals, adequate climbing equipment, sling material, shovel, probe and snow saws
STANDARD	Prepare a bivouac on a glacier IAW the NWTC Mountain Operations Manual.

Learning Step Activity 1 - Glacier Bivouac Procedures

When locating a bivouac site or a gathering area where the team might need or want to unrope, at least one person will need to "probe" the area for hidden crevasses. The best type of probe will be the manufactured collapsing probe pole, at least eight feet in length. Other items could be used but the length and strength of the probe is most important. Other rope team member(s) will belay the prober(s). The prober is "feeling" for a solid platform to place the tent by pushing the probe as hard and deep as possible into the surface. Probing should be in two-foot intervals in all directions within the site.

If the probe suddenly has no resistance while pushing down, a crevasse is present. Attempts to outline the crevasse can be futile if the crevasse is large. The best decision is normally to relocate the proposed area far enough away to avoid that crevasse; sometimes only a few feet one way or the other is all that's required to reach a good platform. Probe the tent site again after digging to the desired surface. Mark boundaries with wands or other items, skis, poles, etc.

Occasionally, while probing, increased pressure will be noticed without reaching a solid platform. The amount of snowfall may be such that even after digging into the snow, the probe still doesn't contact a hard surface. Try to find a solid platform.

There should be no unroped movement outside the probed/marked areas. If there is a need for a latrine area, probe a route away from the site and probe the latrine area also. If a dugout latrine is necessary, probe again after digging.

Multiple tent sites can be connected, this keeps tents closer together. Probe all area between the tents if you plan to move in those areas. Closer tents will ease the ability to communicate between tent groups/rope teams.

If there is a chance for severe storms with high winds, snow walls may be constructed to protect the tent site from wind. The walls can be constructed from loose snow piled on the perimeter or blocks can be cut from consolidated snow layers. In deep soft snow, digging three or four feet to find a consolidated layer will result in enough snow moved to build up decent walls around the tent site.

For block construction, move the soft snow from the digging area into the wall foundation areas. Remove this down to a consolidated layer of snow. Cut blocks approximately 1x1x2 feet and construct the walls by interlocking the blocks with overlapping placements. The walls should be slightly higher than the tent. At a minimum, build walls on the windward side of the tent site. Snow walls can provide a shelter from wind for food preparation also.

For additional considerations for patrol base operations on a glacier refer to TSP M003 Mountain and Glacier (Alpine) Patrol Bases

SECTION IV SUMMARY

Check on Learning

a. Describe the first step to establishing a Z-Pulley rescue system.

Set the initial anchor:

1. Rope team member #2 attempts to communicate with #1. #1 indicates that he needs assistance.
2. The entire load of the fallen climber must be placed on #2 to allow #3 to move forward and anchor the rope. #3 slowly releases his portion of the load onto #2, always being prepared to go back into self-arrest should #2's position begin to fail.
3. Once #2 is confident that he can hold the load, #3 will proceed to #2's position, using the prusik as a self belay. In this way the rope remains reasonably tight between #2 and #3.
4. When #3 reaches #2's position he will establish a bombproof anchor. This should be either a dead man anchor or a two point equalized anchor, as a minimum. For simplicity, the anchor should be set up between the hole and the #2 man. Snow conditions, the size of the crevasse, or other considerations may dictate a different anchor location.
5. #3 ties a prusik with the 12 foot cordallete onto the rope leading to #1 (between the hole and the #2 man). #3 Attaches the cordallete to the anchor with a locking carabiner or two oval carabiners, gates opposite and opposed. If the cordallete does not reach the anchor, girth hitch slings to the cordallete until the anchor can be reached. The prusik knot is adjusted toward the load.
6. #2 can then transfer the load of #1 onto the anchor. Do this gradually, preparing to arrest again if the anchor fails.
7. Once satisfied with the anchor, #3 should clip a safety line to the anchor and can untie from the end of the rope.
8. #2 can now check on the fallen climber and prepare the lip of the crevasse for raising the climber. To do this the #2 climber clips a safety line to the anchor. #2 removes the short prusik and re-attaches it below the prusik holding the load of the climber. #2 now unclips from the climbing rope. #2 unclips the safety line and uses the prusik as a belay down to the hole. #2 should pad the lip to prevent the rope from cutting into the snow. A rucksack or ice axe can be used to accomplish this. #2 communicates with #1 and the two develop a plan to get #1 out of the hole.

b. Describe the process for tying into the rope for glacier travel.

1. Three to four people will tie in to one rope at equal distances from each other. If three people are on a team, one person ties into the middle and the other two at the ends. If four people are on a team, divide the rope into thirds. Two will tie into the end and the other two will tie into the rope keeping equal lengths of rope between all four individuals.
2. Each individual should wear a pre-sewn seat harness or the improvised seat harness.
3. An improvised chest harness should also be worn; if the climber falls the chest harness will keep the climber upright.
4. Each climber ties a figure eight loop and clips this loop to the harness with a locking pear shaped carabiner.
5. The rope is then clipped to the chest harness.
6. Take a 6 foot length of cordallete and tie it into a continuous loop with the double fisherman's knot. Attach this to the rope exiting from the chest harness with a prusik with three wraps. Clip the cordallete to the seat harness with another locking carabiner.
7. Take a 12 foot length of cordallete and tie it into a continuous loop with the double fisherman's knot. Attach this to the rope between the first prusik knot and the chest harness with a prusik with three wraps. Tuck the end of the cordallete into a pocket. This cordallete does not have to be tied to the rope and may be carried on a carabiner attached to the seat harness.
8. Skis or snowshoes should now be donned, if applicable.
9. The rucksack should be rigged for glacier travel. Take a length of webbing and girth hitch it to the frame. Place an oval carabiner into the webbing. Don the pack and clip the carabiner to the rope between the climbing harness and the chest harness.
10. If traveling with a sled, secure it to the rucksack for towing and connect the rear of the sled to the rope with cordallete using the prusik knot. This will prevent it from hitting the climber should he fall into a crevasse.
11. All items should be secured to either you or the rope/harness to prevent inadvertent release and loss of necessary items or equipment.

Review and Summarize Lesson

ACTION	Demonstrate proper roped movement on glaciers
CONDITION	On glaciated terrain, with a 60m 9mm rope per 3-4 individuals, adequate climbing equipment and sling material
STANDARD	Demonstrate proper roped movement on glaciers IAW the NWTC Mountain Operations Manual.

Glacier travel is a complex task that must be practiced prior to executing glacier movement. There are other techniques used for glacier travel and other crevasses rescue systems not described in this TSP. The systems described here are appropriate for military purposes and attempt to use the minimum equipment and the simplest methods.

Transition to next lesson

As per the NWTC training schedule; dependent upon the course in conduct

SECTION V	STUDENT EVALUATION
Testing Requirements	**Students will be tested on this task during the Alpine FTX and questions related to the subject matter may appear on the written test.**
Feedback Requirement	**Students will receive two opportunities to pass each event tested. Re-training will be conducted for students that fail the first iteration of testing. Refer to M020 for specifics.**